

CLAIMS

1. A method for detecting features of an object comprising:

scanning at least one of the object, an area immediately surrounding the object, and an interior of the object, wherein a scanning particle trapped within a trapping potential performs the scan, said scanning being effected by:

configuring the trapping potential in a position zone defined relative to one of the object and a reference point in a first position determining stage associated with a first order of magnitude, and

performing a substantially free three-dimensional scan within a scan volume associated with the position zone using the scanning particle trapped within and controlled by the trapping potential in a second position determining stage associated with a second order of magnitude smaller than the first order of magnitude of the first position determining stage; and

detecting a plurality of positions assumed by the scanning particle while scanning the scan volume, wherein the features of the object detected are at least one of physical, chemical, and biological.

2. The method according to claim 1, wherein the first order of magnitude is microscopic and the second order of magnitude is sub-microscopic.

3. The method according to claim 2, wherein the trapping potential is configured by a microscopic process in the position zone and the scanning particle sub-microscopically scans the scan volume based on a sub-microscopic process.

4. The method according to claim 3, wherein the microscopic process is an optical process.

5. The method according to claim 1, wherein the scanning of the scan volume by the scanning particle is performed such that a motion of the scanning particle within the scan volume is one of random and near-random on a time scale that is longer than an auto-correlation time.

6. The method according to claim 5, wherein the motion of the scanning particle is detected during a detection interval that exceeds the auto-correlation time interval in order to attain at least one of a plurality of uncorrelated or nearly uncorrelated scanning particle positions detected at different points in time, information about the object, the area surrounding the object, and the interior of the object.

7. The method according to claim 5, wherein the motion of the scanning particle is detected during a detection time interval corresponding to or shorter than the auto-correlation time in order to attain information about at least one of the object, the area surrounding the object, the interior of the object, and a diffusive behavior of the scanning particle.

8. The method according to claim 5, wherein said motion of the scanning particle corresponds to a given statistics.

9. The method according to claim 8, wherein said statistics is Maxwell-Boltzmann statistics.

10. The method according to claim 1, wherein the scanning of the scan volume by the scanning particle is based, at least in the sense of a contribution to the scanning, on thermally induced changes in the particle position.

11. The method according to claim 1, wherein the scanning of the scan volume by the scanning particle is based, at least in the sense of a contribution to

the scanning, on electromagnetically induced changes in position of the scanning particle, wherein the change of position of the scanning particle is induced by changing an external electromagnetic field interacting with the scanning particle.

12. The method according to claim 11, wherein the external electromagnetic field is a field co-generating the trapping potential and the trapping potential is an effective potential defining interaction of the scanning particle with the external electromagnetic field on a time scale associated with the first position determining stage.

13. The method according to claim 1, wherein the scanning of the scan volume by the scanning particle is based, at least in the sense of a contribution to the scanning, on mechanically or acoustically induced position changes of the scanning particle.

14. The method according to claim 13, wherein at least one of an object support bearing the object and a probe chamber containing the object are loaded mechanically or acoustically in order to change the position of the scanning particle.

15. The method according to claim 1, wherein electromagnetic radiation emanating from and/or passing through the scanning particle is detected to determine the position of the scanning particle within the scan volume.

16. The method according to claim 15, wherein the electromagnetic radiation emanating from the scanning particle includes radiation scattered or reflected by the scanning particle.

17. The method according to claim 15, wherein the electromagnetic radiation emanating from the scanning particle includes recombination radiation based on atomic and/or molecular transitions associated with the scanning particle.

18. The method according to claim 17, wherein said recombination radiation is induced by a multi-photon process.

19. The method according to claim 1, wherein an electromagnetic radiation interference pattern is analyzed to detect the position of the scanning particle within the scan volume, wherein the interference pattern depends on the position of the scanning particle.

20. The method according to claim 1, wherein the trapping potential is generated using optical or laser radiation interacting with the scanning particle.

21. The method according to claim 20, wherein electromagnetic radiation is detected to ascertain the position of the scanning particle within the scan volume, wherein said electromagnetic radiation results from an interaction of the optical or laser radiation with the scanning particle.

22. The method according to claim 1, wherein the position zone of the trapping potential relative to the object is changed by changing at least one of the position zone of the trapping potential and the object position.

23. The method according to claim 22, wherein a scanning of a region transcending at least one of the scan volume and the range of the trapping potential is performed by changing the position zone of the trapping potential.

24. The method according to claim 1, wherein a change of any one of the object, the area immediately surrounding the object, and the interior of the object is detected over a time interval of change, wherein the position zone of the trapping potential is maintained during the time interval of change, and a plurality of assumed positions of the scanning particle is detected within the scan volume during the time interval of change.

25. The method according to claim 1, further comprising the step of changing at least one of a potential field intensity and potential function of the trapping potential in order to change the scan volume associated with a given position zone.

26. The method according to claim 1, wherein a particle is used as the scanning particle which is at least one of spherical and fluorescent.

27. The method according to claim 1, wherein one of a metal particle, a high-grade metal particle, a latex particle, a glass particle, a nano-particle, and a quantum dot are used as the scanning particle.

28. The method according to claim 1, wherein a scanning particle having special interacting properties relative to the object is used.

29. The method according to claim 1, wherein several scanning particles are used within a common trapping potential.

30. The method according to claim 1, wherein the features of the object refer to at least one of the object, the area immediately surrounding the object and the interior of the object.

31. The method according to claim 1, wherein said scanning is further effected by:

changing the position zone of the trapping potential relative to the object by changing at least one of the position zone of the trapping potential and the position of the object, in order to scan a region transcending at least one of the scan volume and the range of the trapping potential.

32. The method according to claim 31, wherein the region transcending the scan volume is scanned by superposing on the scan of the scanning particle within the

scan volume associated with the second order of magnitude a higher-ranking scan by changing the position zones of the trapping potential associated with the first order of magnitude.

33. The method according to claim 32, wherein the higher-ranking scan is carried out according to a scanning strategy wherein the position zone of the trapping potential is changed while taking into account at least one scanning result associated with the second order of magnitude.

34. A method for detecting features of an object comprising:
scanning at least one of the object, an area immediately surrounding the object, and an interior of the object, wherein a scanning particle trapped within a trapping potential performs the scan and at least one particle position is detected; said scanning being effected by:

configuring the trapping potential in a position zone defined relative to one of the object and a reference point in a first position determining stage associated with a first order of magnitude;

performing a substantially free three dimensional scan within a scan volume associated with the position zone using the scanning particle trapped within and controlled by the trapping potential in a second position determining stage associated with a second order of magnitude smaller than the first order of magnitude of the first position determining stage; and

changing the position zone of the trapping potential relative to the object by changing at least one of the position zone of the trapping potential, the position of the object in order to scan a region transcending at least one of the scan volume and

a range of the trapping potential, wherein the features of the object detected are at least one of physical, chemical, and biological.

35. The method according to claim 34, wherein the region transcending the scan volume is scanned by superposing on the scan of the scanning particle within the scan volume associated with the second order of magnitude a higher-ranking scan by changing the position zones of the trapping potential associated with the first order of magnitude.

36. The method according to claim 35, wherein the higher-ranking scan is carried out according to a scanning strategy wherein the position zone of the trapping potential is changed while taking into account at least one scanning result associated with the second order of magnitude.

37. The method according to claim 34, wherein the first order of magnitude is microscopic and the second order of magnitude is sub-microscopic.

38. The method according to claim 37, wherein the trapping potential is configured by a microscopic process in the position zone and the scanning particle sub-microscopically scans the scan volume based on a sub-microscopic process.

39. The method according to claim 38, wherein said microscopic process is an optical process.

40. The method according to claim 34, wherein the scanning of the scan volume by the scanning particle is performed such that a motion of the scanning particle within the scan volume is one of random and near-random on a time scale that is longer than an auto-correlation time.

41. The method according to claim 40, wherein the motion of the scanning particle is detected during a detection interval that exceeds the auto-correlation time

interval in order to attain at least one of a plurality of uncorrelated or nearly uncorrelated scanning particle positions detected at different points in time, information about the object, the area surrounding the object, and the interior of the object.

42. The method according to claim 40, wherein the motion of the scanning particle is detected during a detection time interval corresponding to or shorter than the auto-correlation time in order to attain information about at least one of the object, the area surrounding the object, the interior of the object, and a diffusive behavior of the scanning particle.

43. The method according to claim 40, wherein said motion of the scanning particle corresponds to a given statistics.

44. The method according to claim 43, wherein said statistics is Maxwell-Boltzmann statistics.

45. The method according to claim 34, wherein the scanning of the scan volume by the scanning particle is based, at least in the sense of a contribute to the scanning, on thermally induced changes in the particle position.

46. The method according to claim 34, wherein the scanning of the scan volume by the scanning particle is based, at least in the sense of a contribute to the scanning, on electromagnetically induced changes in position of the scanning particle, wherein the change of position of the scanning particle is induced by changing an external electromagnetic field interacting with the scanning particle.

47. The method according to claim 46, wherein the external electromagnetic field is a field co-generating the trapping potential and the trapping potential is an effective potential defining interaction of the scanning particle with the

external electromagnetic field on a time scale associated with the first position determining stage.

48. The method according to claim 34, wherein the scanning of the scan volume by the scanning particle is based, at least in the sense of a contribute to the scanning, on mechanically or acoustically induced position changes of the scanning particle.

49. The method according to claim 48, wherein at least one of an object support bearing the object and a probe chamber containing the object are loaded mechanically or acoustically in order to change the position of the scanning particle.

50. The method according to claim 34, wherein electromagnetic radiation emanating from and/or passing through the scanning particle is detected to determine the position of the scanning particle within the scan volume.

51. The method according to claim 50, wherein the electromagnetic radiation emanating from the scanning particle includes radiation scattered or reflected by the scanning particle.

52. The method according to claim 50, wherein the electromagnetic radiation emanating from the scanning particle includes recombination radiation based on atomic and/or molecular transitions associated with the scanning particle.

53. The method according to claim 52, wherein said recombination radiation is induced by a multi-photon process.

54. The method according to claim 34, wherein an electromagnetic radiation interference pattern is analyzed to detect the position of the scanning particle within the scan volume, wherein the interference pattern depends on the position of the scanning particle.

55. The method according to claim 34, wherein the trapping potential is generated using optical or laser radiation interacting with the scanning particle.

56. The method according to claim 55, wherein electromagnetic radiation is detected to ascertain the position of the scanning particle within the scan volume, wherein said electromagnetic radiation results from an interaction of the optical or laser radiation with the scanning particle.

57. The method according to claim 34, wherein the change of the position zone of the trapping potential relative to the object is implemented by changing at least one of the position zone of the trapping potential and the object position.

58. The method according to claim 34, wherein a change of any one of the object, the area immediately surrounding the object, and the interior of the object is detected over a time interval of change, wherein the position zone of the trapping potential is maintained during the time interval of change, and a plurality of assumed positions of the scanning particle is detected within the scan volume during the time interval of change.

59. The method according to claim 34, further comprising the step of changing at least one of a potential field intensity and potential function of the trapping potential in order to change the scan volume associated with a given position zone.

60. The method according to claim 34, wherein a particle is used as the scanning particle which is at least one of spherical and fluorescent.

61. The method according to claim 34, wherein one of a metal particle, a high-grade metal particle, a latex particle, a glass particle, a nano-particle, and a quantum dot are used as the scanning particle.

62. The method according to claim 34, wherein a scanning particle having special interacting properties relative to the object is used.

63. The method according to claim 34, wherein several scanning particles are used within a common trapping potential.

64. The method according to claim 34, wherein the features of the object refer to at least one of the object, the area immediately surrounding the object and the interior of the object.

65. An apparatus to implement the method claimed in either one of claims 1 and 34, comprising:

a system generating a trapping potential at a desired position zone associated with a first order of magnitude; and

a detection system detecting the positions of at least one scanning particle which is trapped within the trapping potential and carries out a substantially free three-dimensional motion under the effect of the trapping potential within a scanning volume associated with the position zone, the detected positions being associated with a second order of magnitude less than the first order of magnitude.